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(54) Apparatus and method for modifying displayed color images.

(57) An apparatus and method are disclosed which permits selection of colors for display, and easy modification of displayed colors. The apparatus includes a microprocessor, a ROM with a stored program, a RAM with modifiable color data, a CRT display for displaying color images, and a keyboard with cursor-positioning key for identifying a pixel of a displayed color image, and a color menu and H (hue), L (lightness), S (saturation) color modification keys. In response to actuation of one or more of the color modification keys, the microprocessor, under control of the stored program, modifies the stored color data, and uses the modified colcor data to control the color guns (red, green, blue) of the CRT to modify the color of the identified pixel.

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APPARATUS AND METHOD FOR MODIFYING DISPLAYED COLOR IMAGES

Background of the Invention

This invention relates generally to color display systems, and more particularly to color-selective graphic display terminals.

Many currently available display terminals require users to have a thorough understanding of color theory and how colors combine, and to enter substantial amounts of data before a desired color may be displayed. For example, one such terminal is the Megetek 1650 graphic terminal manufactured by Megatek Corporation of San Diego, California, U.S.A. To specify a color index and selected color coordinates (i.e., selected amounts of red, green, and blue base colors from which a resultant color or index is to be formed), such terminals often require the entry of four data values to specify the color index, followed by the entry of three more data values to specify the color coordinates; and even when the user satisfies these requirements, the specified color is often not displayed when its index is different from that of a previous image. To avoid this problem, the user often has to enter a display command; and, to do this, he is required to specify a color polygon, then build the polygon, coordinate by coordinate, superimposing the selected (desired resultant) color on the ploygon -- a multistep, often laborious process.

What is needed and would be useful, therefore, is a color selection and display apparatus which simplifies the process of color selection/specification.

Summary of the Invention

Accordingly, an apparatus is provided which permits easy selection of colors for display, and easy modification of displayed colors. In accordance with the illustrated preferred embodiment of the present invention, the apparatus comprises a keyboard, a microprocessor, a ROM (read-only- memory) with a stored program, a RAM (random-access memory) with predetermined, changeable color data, and a CRT (cathode- ray tube) display for displaying color images. The keyboard includes a color menu key for initiating the display of a color menu, a disk key for selecting a color name from the menu or for specifying an image segment whose color is to be modified, and H (hue), L (lightness), S (saturation) keys for entering color modification data. In response to actuation of one or more of said keys, the microprocessor, under control of the stored program, modifies the color data and uses the modified color data to control the color (red, green, blue) guns of the CRT to produce a desired resultant color display.

Brief Description of the Drawings

Figure 1 is a block diagram of the apparatus of the present invention

Figure 2 is a graphic representation of an initial color image displayed by the apparatus of Figure 1;

Figure 3 is a top view of a keyboard of the apparatus of Figure 1;

Figure 4 is a graphic representation of a bit map arrangement of modifiable color data initialized by the apparatus of Figure 1;

Figure 5 is an exploded view of a color model having hue, lightness, and saturation coordinates corresponding to selected ones of the modifiable color data;

Figure 6 is a graphic representation of the color image of Figure 2 with the hue coordinate modified;

Figure 7 is a graphic representation of the color image of Figure 2 with the lightness coordinate modified;

Figure 8 is a graphic representation of the color image of Figure 2 with the saturation coordinate modified;

Figure 9 is a graphic representation of the color image of Figure 2 including a color menu; and

Figure 10 is a graphic representation of the color image of Figure 2 modified in accordance with selection of the orange color from the color menu of Figure 9.

Description of the Preferred Embodiment

Referring to Figure 1, there is shown a system (apparatus) of the present invention comprising an alphanumeric keyboard 11 with cursor-positioning key or disk 13, microprocessor 15, read-only memory 17 for storing system control programs, random-access memory 19 for storing variables such as color data, and CRT raster scan display 21 for displaying color in accordance with selected ones of the stored color data.

Figure 2 shows a graphic image, in color (e.g., medium green), displayed on screen 22 of CRT display 21. To change the color of a segment (e.g., segment

23) of the image, the user of the system first positions cursor 25 at a pixel 27 (picture element) or portion of the segment to be changed, then actuates (depresses and releases) one or more of the hue, lightness, and saturation keys 29, 31, 33, respectively of keyboard 11 shown in Figure 3. Cursor positioning is accomplished by actuation of disk key 13.

A color index is associated with each pixel. If the screen 22 is represented by an X-Y matrix of 480 x 360 pixels, for example, there will be correspondingly 172,800 indexes, one index associated with each pixel. An index is a series of bits which is used to address (point to) color coordinate values stored in RAM 19. For example, a series of three bits may be used to denote indexes 0-7, each index representing the starting address of a group of three color coordinate words 35, 37, 39, as shown in Figure 4. The contents of the first, second, and third words 35, 37, 39 of each group represents hue data, lightness data, and saturation data, respectively, for the associated index. The hue, lightness, and saturation data correspond spatial (angular, vertical, radial) coordinates of an HLS (hue, lightness, saturation) color cone as shown in Figure 5. Upon successive actuations of hue key 29, the color of the image segment at cursor position 27, and all other segments having the same color index, is changed discretely (e.g., each actuation corresponding to a 20° change) in a clockwise manner around the cone (i.e. 0 to 360 degrees) as shown in Figure 5. For example, when hue key 29 is actuated three times from the hue value of 240° shown in Figure 2, the hue value is changed from 240° to 300°, causing the color of all image segments having the same index as that of the pixel at the middle green color of Figure 2 to the cyan color of Figure 6. Likewise, upon successive actuations of lightness key 31, the color of the image

segment at cursor position 27, and all other segments having the same color index, is changed discretely (e.g., each actuation corresponding to a 10% change) from 0% to 100% vertically up the cone as shown in Figure 5. From 100%, further actuation of key 31 causes color lightness to start varying again from 0% (black) toward 100% (white). For example, when lightness key 50% is shown in Figure 2, the lightness value is changed from 50% to 80%, causing the color of all image segments having the same index as that of the pixel at cursor position 27 to change from the medium light green color of Figure 7. Similarly, upon successive actuations of saturation key 33, the color of the image segment at cursor position 27, and all other segments having the same color index, is changed discretely (e.g., each actuation corresponding to a 25% change) from 0% at the axis of the cone to 100% toward the periphery of the cone, as shown in Figure 5. From 100%, further actuation of key 33 causes color saturation to start varying again from 0% (no saturation) toward 100% (maximum saturation). For example, when saturation key 33 is actuated twice from the saturation value of 100% shown in Figure 2, the saturation value is changed from 100% to 0% to 25%, causing the color of all image segments having the same index as that of the pixel at cursor position 27 to change from the maximum saturated green color of Figure 2 to less saturated green color of Figure 8.

Whenever the hue, lightness, and saturation values are changed for a given index (e.g., for the index three associated with the pixel at cursor position 27 shown in Figures 2 and 6 to 8) because of actuation of the hue, lightness and saturation keys 29, 31 and 33, the changed values are stored as new hue, lightness and saturation coordinate values in words 35, 37, and 39 for that index. As shown in

Figures 2 and 6-8, the coordinate values and associated index indicative of a particular color are displayed for the user's convenience if the user wishes to specify the same color at a later time. To do so, the user merely enters, via keyboard 11, the coordinates and index for that color.

The foregoing represents one method of changing color of image segments. The following represents another method, utilizing a color menu. Referring to Figure 2, there is shown a displayed image with cursor positioned at a pixel 27, the color of which pixel 27 (and associated segment 23) the user desires to change. Figure 3 shows keyboard 11 having a color menu key 41. Upon depression of key 41, a color menu 43 is displayed at a predetermined distance proximate to the cursor. To select a color from the menu and to have the color of the pixel at which the cursor is positioned change to the selected color, the user simply moves the cursor, by repeated actuations of disk key 13, and positions it on the menu color of his choice as shown, for example, in Figure 9. Thereafter, upon release of color menu key 41, the color of the pixel (and of all image segments having the same color index as that of the pixel) is changed to the color selected from the menu, and display of the menu is terminated, as shown in figure 10. Each color of the menu is represented by three HLS color coordinate values. These coordinate values, which are predetermined, are stored in ROM 17.

Thus, the color menu key and the HLS keys may be viewed as color modification devices. After the HLS coordinate values are changed in response to actuation of one of the HLS keys, or actuation of the color menu key the changed values are converted by known methods to RGB (red, green, blue) values which are used by the CRT display to regulate the output of its RGB guns.

Claim:

1. Color display apparatus having at least one color modification device, the apparatus comprising:

means for identifying a pixel of a displayed color image; and

means for modifying the color of the pixel in response to actuation of said color modification device.

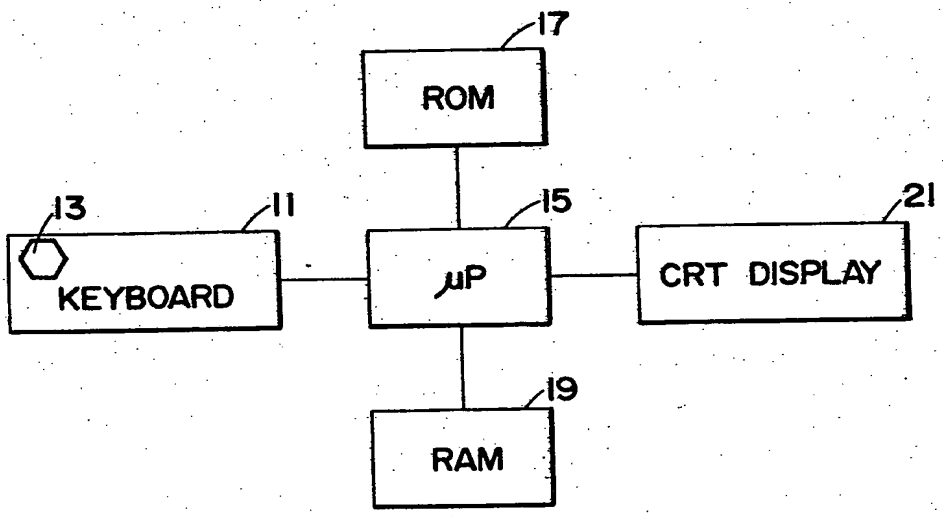
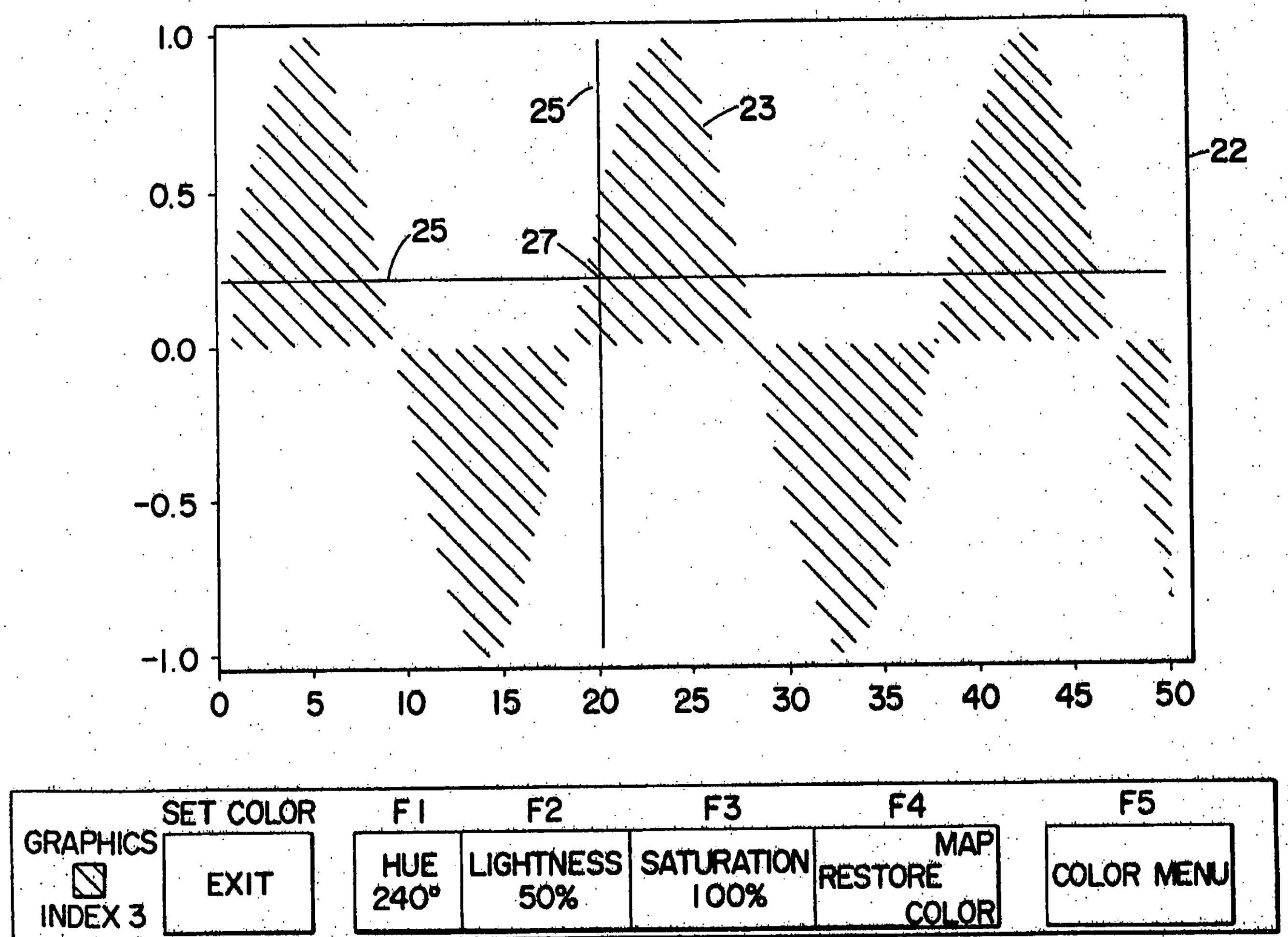


Fig 1.

Fig 2.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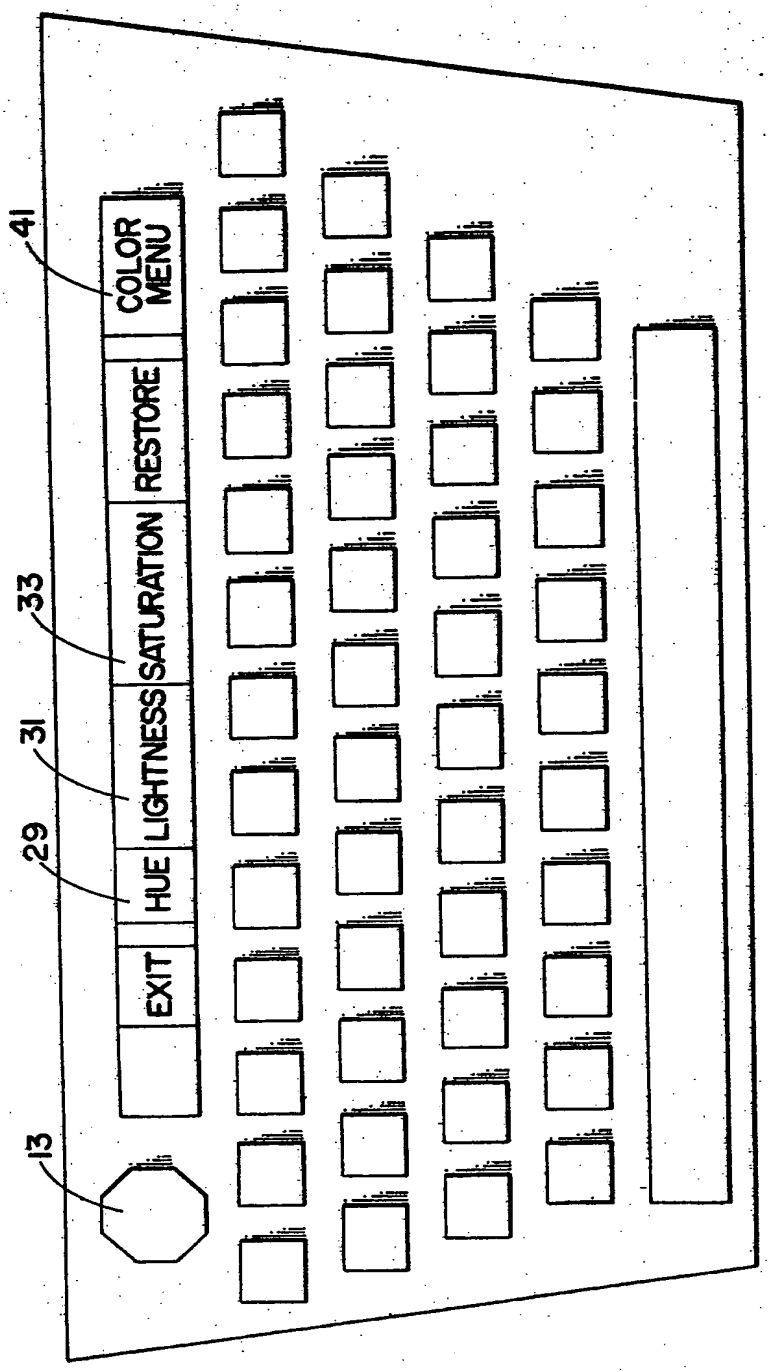
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
50
25
25
27
23
22
GRAPHICS
INDEX 3
SET COLOR
EXIT
F1
HUE
240°
F2
LIGHTNESS
50%
F3
SATURATION
100%
F4
MAP
RESTORE
COLOR
F5
COLOR MENU

FIG 2.


41
COLOR MENU
RESTORE
33
SATURATION
31
LIGHTNESS
29
HUE
EXIT
13

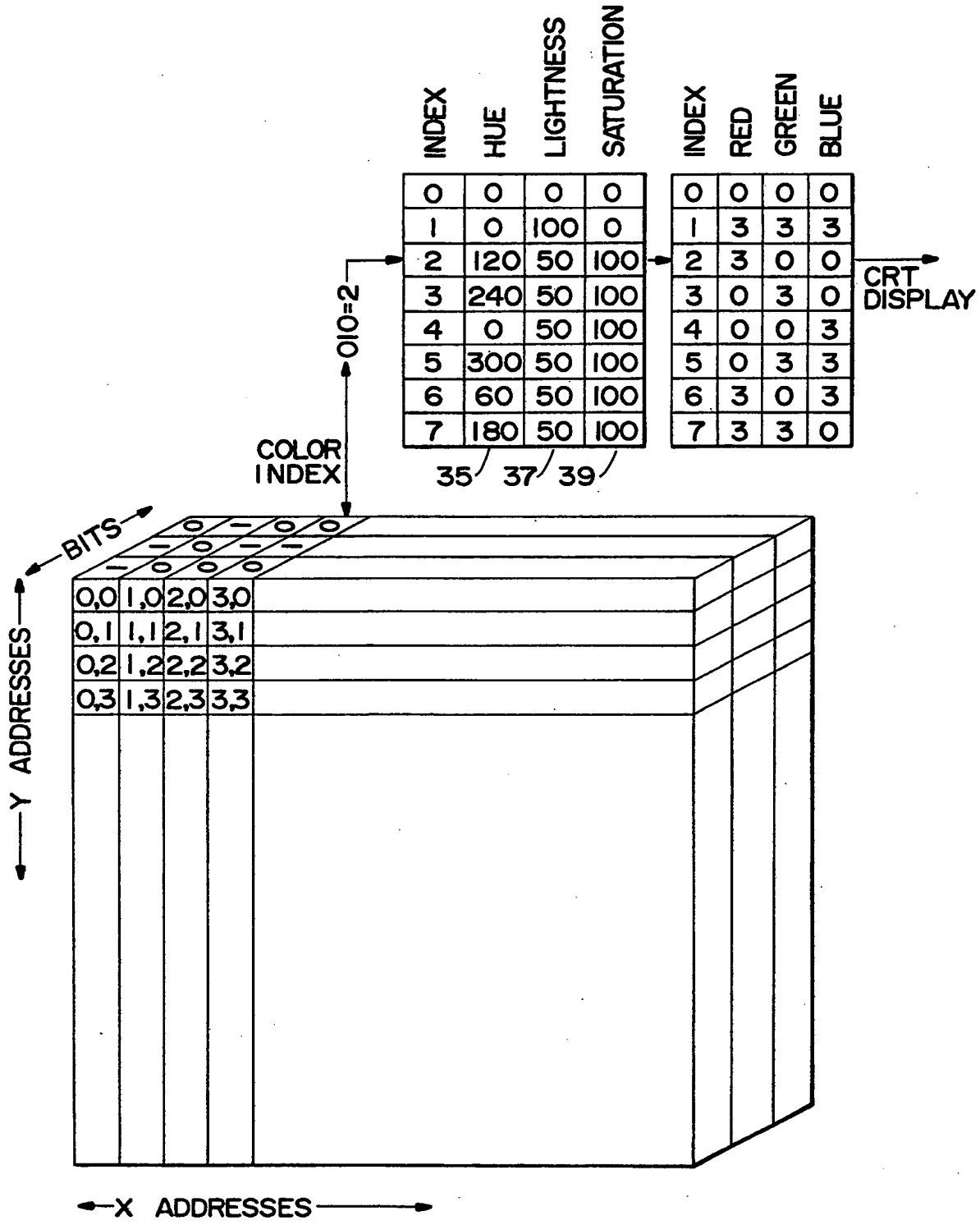

INDEX
HUE
LIGHTNESS
SATURATION
INDEX
RED
GREEN
BLUE
0 0 0 0 0 0 0 0
1 0 100 0 1 3 3 3
2 120 50 100 2 3 0 0
3 240 50 100 3 0 3 0
4 0 50 100 4 0 0 3
5 300 50 100 5 0 3 3
6 60 50 100 6 3 0 3
7 180 50 100 7 3 3 0
CRT DISPLAY
010=2
COLOR INDEX
35
37
39
BITS
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0
0,0 1,0 2,0 3,0
0,1 1,1 2,1 3,1
0,2 1,2 2,2 3,2
0,3 1,3 2,3 3,3
Y ADDRESSES
X ADDRESSES

Fig. 4

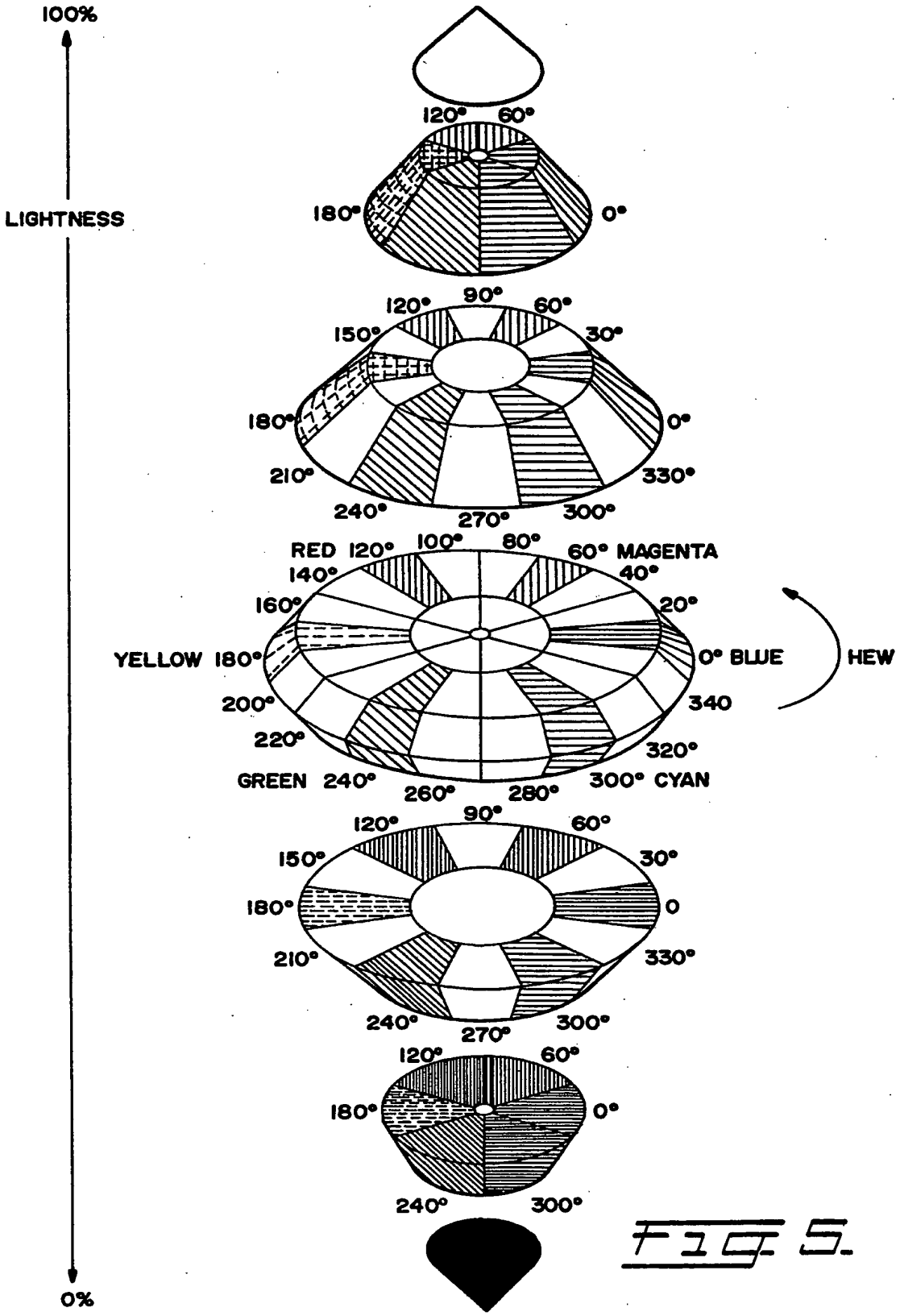
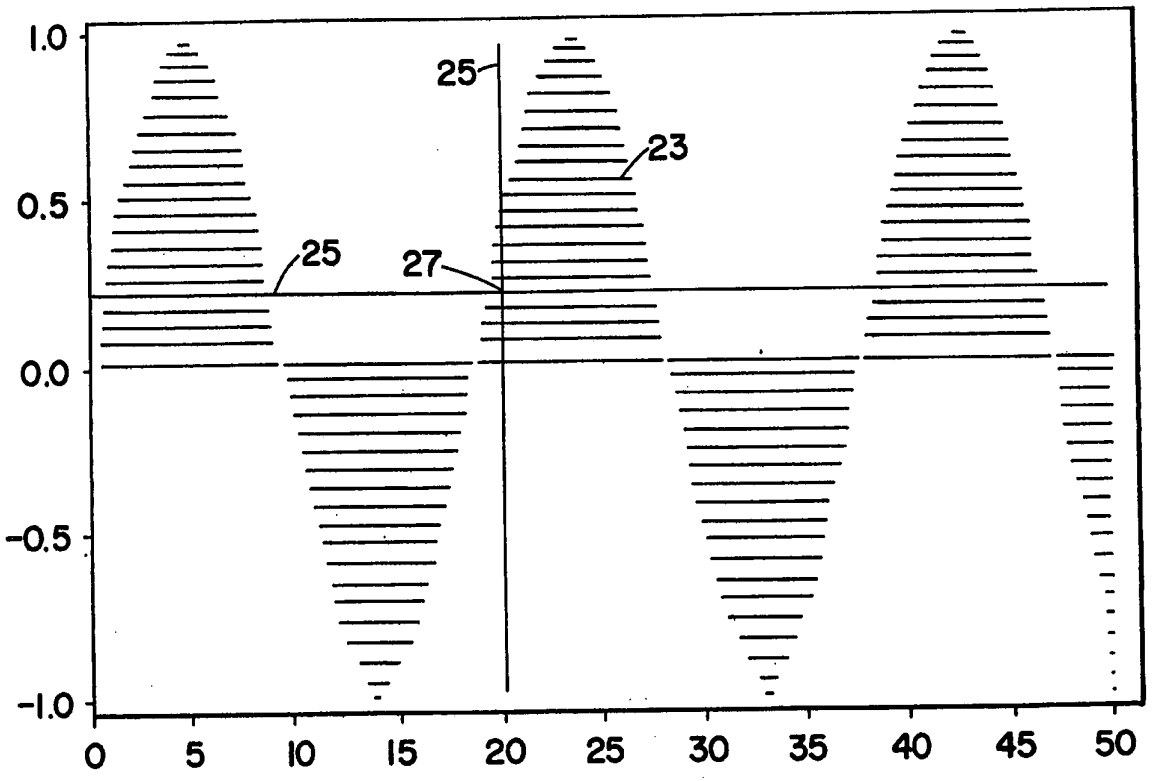

100%
LIGHTNESS
0%
120°
60°
180°
0°
90°
120°
60°
150°
30°
180°
0°
210°
330°
240°
270°
300°
RED 120°
100°
80°
60° MAGENTA
140°
40°
160°
20°
YELLOW 180°
0° BLUE
HEW
200°
340
220°
320°
GREEN 240°
260°
280°
300° CYAN
90°
120°
60°
150°
30°
180°
0
210°
330°
240°
270°
300°
120°
60°
180°
0°
240°
300°

Fig. 5.

Fig 6.



GRAPHICS / INDEX 3	SET COLOR	F1	F2	F3	F4	F5
	EXIT	HUE 300°	LIGHTNESS 50%	SATURATION 100%	MAP RESTORE COLOR	COLOR MENU

6/10

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FIG 7.

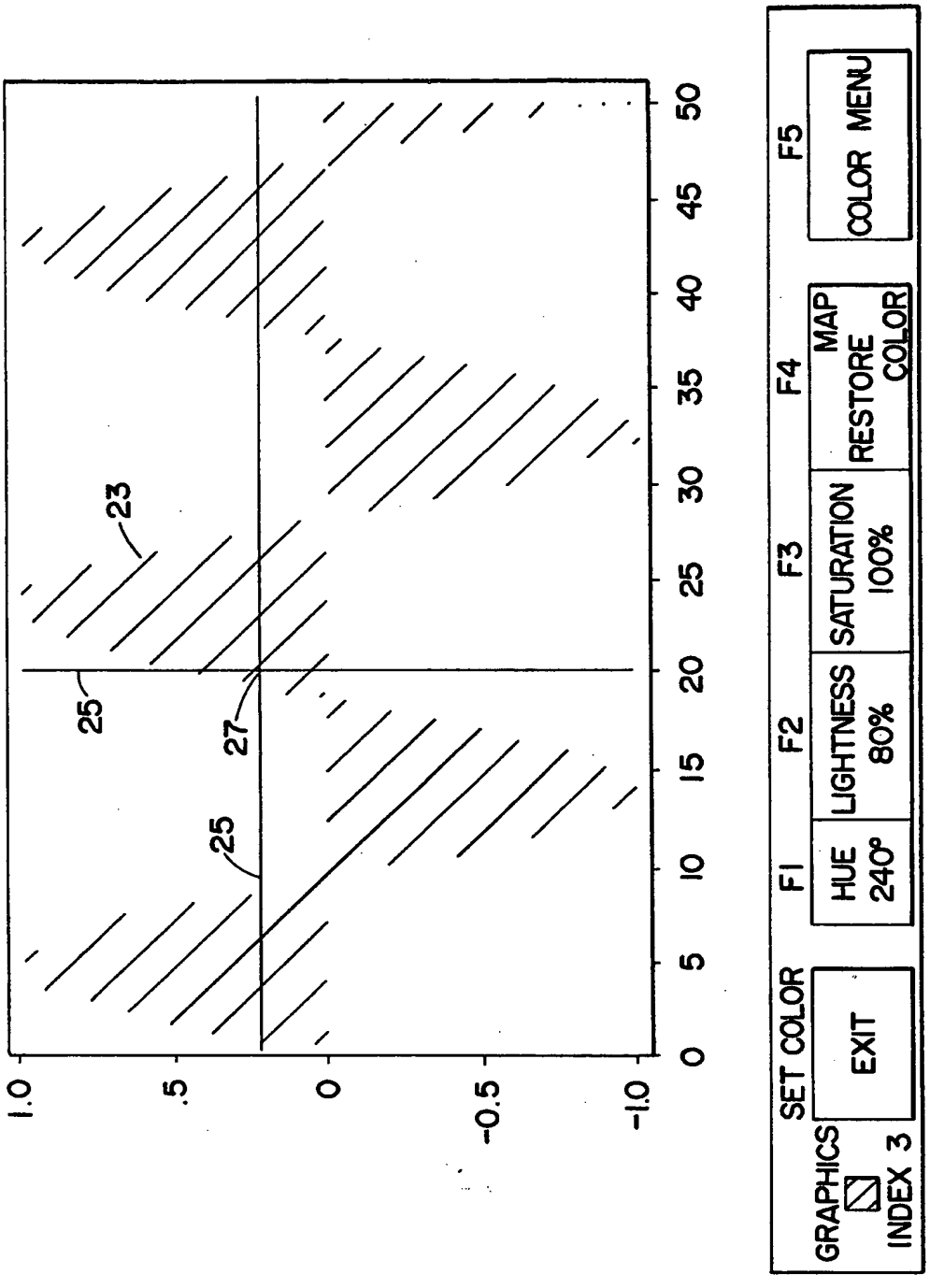
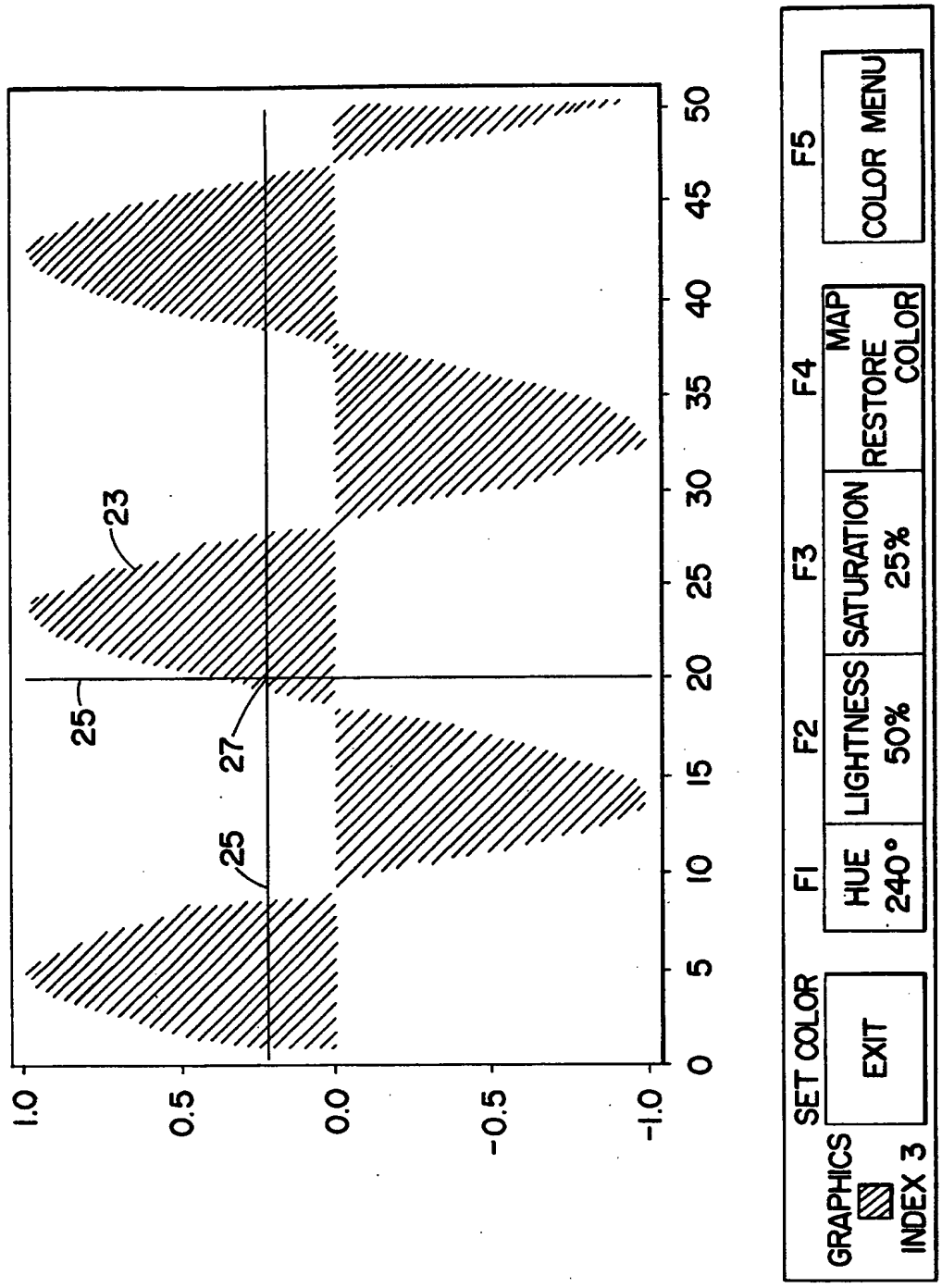

1.0
.5
0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
50
23
25
27
25
SET COLOR
F1
F2
F3
F4
F5
GRAPHICS
INDEX 3
EXIT
HUE 240°
LIGHTNESS 80%
SATURATION 100%
RESTORE COLOR
MAP
COLOR MENU

FIG 4.


1.0
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0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
50
23
25
27
25
GRAPHICS
INDEX 3
SET COLOR
EXIT
F1
HUE
240°
F2
LIGHTNESS
50%
F3
SATURATION
25%
F4
RESTORE
COLOR
MAP
F5
COLOR MENU

Fig 9.

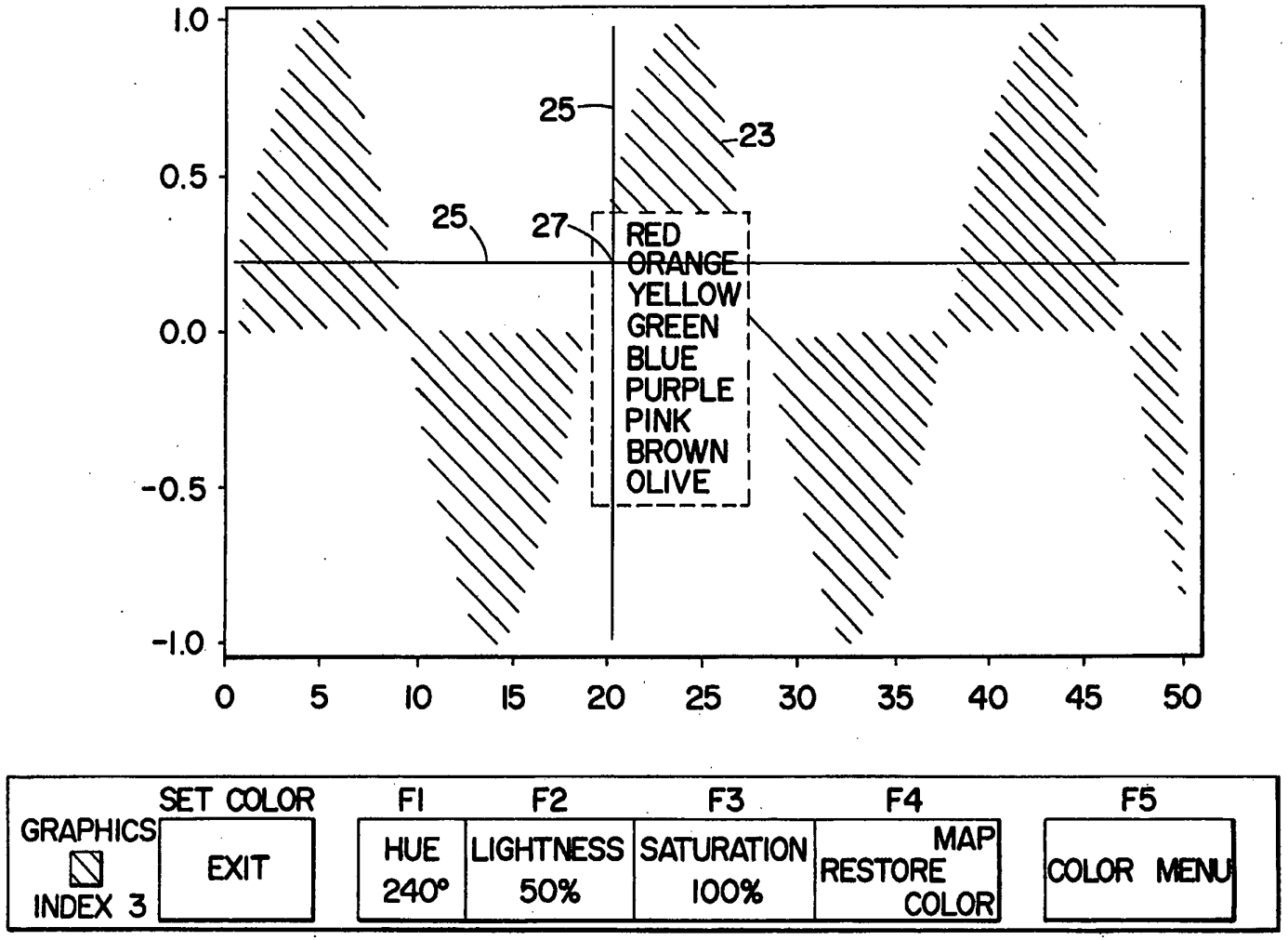
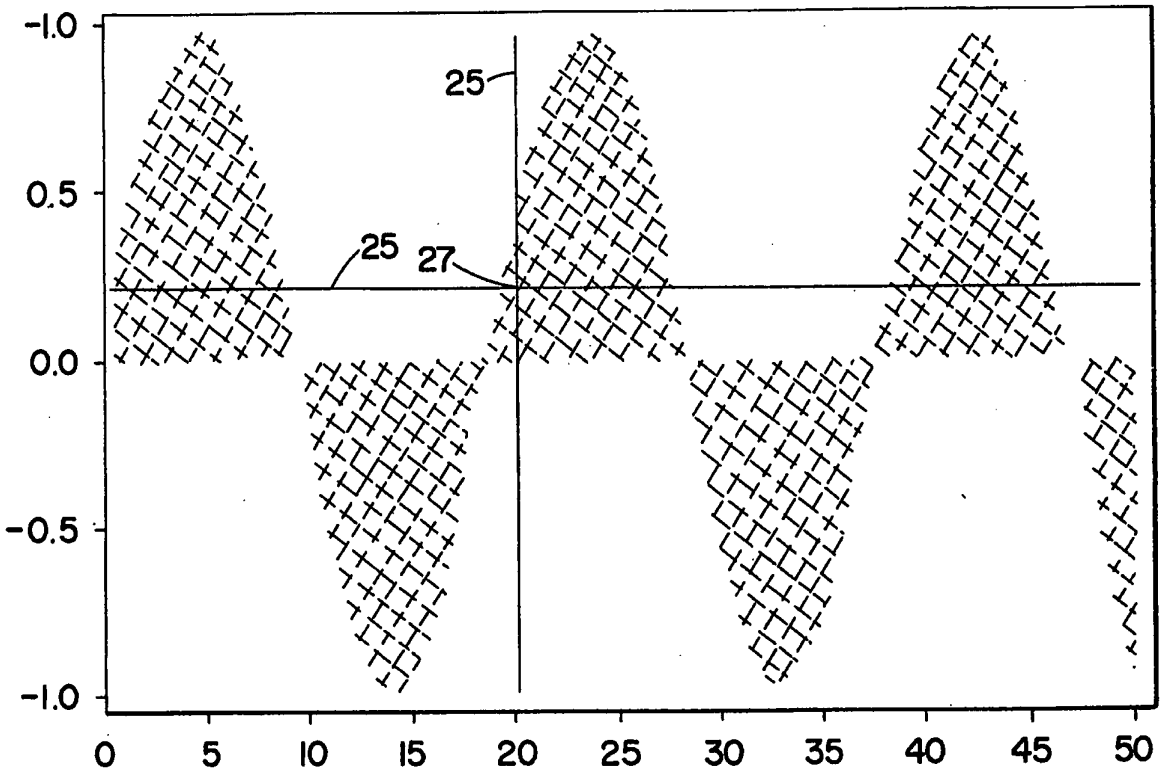


Fig. 10.



GRAPHICS INDEX 3	SET COLOR	F1	F2	F3	F4	F5
	EXIT	HUE 160°	LIGHTNESS 50%	SATURATION 100%	MAP RESTORE COLOR	COLOR MENU